ID37- RANGE-ONLY BENTHIC ROVER LOCALIZATION OFF THE CENTRAL CALIFORNIA COAST

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Abstract—. Nowadays, the use of autonomous vehicles for ocean research has increased, since these vehicles have a better cost/performance ratio than crewed vessels or oceanographic ships. For example, autonomous surface vehicles can be used to localize underwater targets. This paper describes a mission to find a crawling robot - Benthic Rover - on the abyssal plain in the north eastern Pacific, using single-beacon localization from onboard a Wave Glider autonomous surface vehicle. While the Wave Glider is moving around the surface in the target zone, it takes ranges between the target and itself using acoustic modems. With these ranges it can compute the target location, as a Long Baseline (LBL) system. The benefit of this approach is the reduction of cost and complexity relative to deployment of a traditional shipboard LBL system. Additionally, this is a mobile system, and can cover long distances, and can geolocate multiple targets over a large area.

Keywords— target localization, underwater, vehicle, acoustic, benthic rover

I. INTRODUCTION

One of the main challenges in oceanographic research is that of underwater positioning. Is well known that GPS signals suffer a large attenuation underwater. Therefore different methods and architectures have been developed using acoustic signals, which have better underwater performance.

This paper presents a range-only target localization method, using a Wave Glider autonomous surface vehicle [1] that acoustically ranges to an underwater target while moving on the surface, using the ranges to compute target position. Therefore, we can consider this method as an LBL system with only one moving transponder on the sea surface.

The method presented in this paper can be used in a wide range of applications using the long-duration, autonomous navigation and computational characteristics of the Wave Glider, to locate stationary or slowly moving targets on the seabed or in the water column. In this work we present results of a mission to find a slowly moving crawling robot on the abyssal plain off the central California coast.

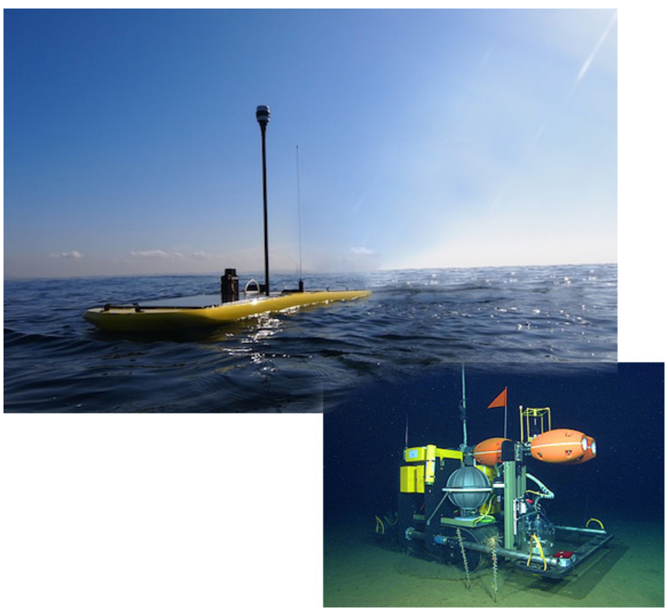

Fig. 1 Mission carried out in Monterey Bay, California, to localize a benthic Rover (down-right picture) using a Wave Glider (up-left picture) as a moving LBL.

II. MISION CHARACTERISITICS

The benthic Rover (fig. 1) is a mobile physiology laboratory designed by Dr. Ken Smith at MBARI, which slowly crawls along the seafloor [2]. Typically, it moves about 5 m, stops to take a set of measurements for 3 days, then it moves another 5 meters to the next location. It can stay underwater for six to nine months, therefore it can travel hundreds of meters during this period. Therefore it is necessary to periodically determine its position in order to map the location of the measurement sites, and to eventually recover the vehicle. The Rover is equipped with an acoustic modem, to enable data and command exchange and ranging with a surface vehicle.

The most recent Rover deployment is at "Station M" in the north eastern Pacific, at 34o 50'N, 123o 00'W, 4000 meters depth, 220 km west of the central California coast. This location is approximately known from previous shipboard acoustic measurements.

The Wave Glider is equipped with an acoustic modem compatible with the one installed on the Rover. On April 14, 2016, we sent the Wave Glider to the Rover target zone to test our auto-localization algorithm. In our algorithm, the Wave Glider autonomously swims in a circle of specified radius, centered near the estimated target location. While swimming in the circle, the Wave Glider's onboard acoustic modem periodically measures the range to the target's acoustic modem.

Fig. 1 Mission carried out in Monterey Bay, California, to localize a benthic Rover (down-right picture) using a Wave Glider (up-left picture) as a moving LBL.

With these ranges and the GPS position of the Wave Glider, our software computes the target location using least squares or iterative minimization algorithms.

Detailed descriptions of the algorithm, mission characteristics such as mission time, maneuvers, initial deployment and Rover movements will be shown in the extended version of this paper.

III. RESULTS

The results obtained are shown in fig. 2, in which the circular path executed by the Wave Glider (round dots) and the computed Rover position (triangle) are shown. Furthermore, we can see range obtained for each Wave Glider position on the color bar. The UTM position for benthic Rover obtained with this algorithm is (500523.820928, 3888509.15227, 3977.3), which is x, y and z in meters.

Figure 2. Target localization results. In this picture we can see the circular path executed by the Wave Glider in order to localize a benthic Rover.

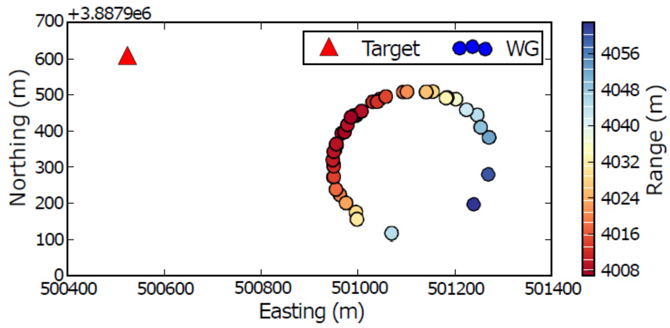

Figure 2. Target localization results. In this picture we can see the circular path executed by the Wave Glider in order to localize a benthic Rover.

IV. CONCLUSIONS

This work describes a field test conducted to acoustically localize a benthic Rover deployed at 4000 m depth from an autonomous surface vehicle. For this purpose a new application using a Wave Glider as a single-beacon LBL has been developed. The work presented in this paper proves the good performance of this method.

ACKNOWLEDGMENT

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ID38- DATA COMPARISON BETWEEN THREE ACOUSTIC DOPPLER CURRENT PROFILERS DEPLOYED IN OBSEA PLATFORM IN NORTH-WESTERN MEDITERRANEAN

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Abstract – Three different Acoustic Doppler Current Profilers (ADCP) have been deployed in OBSEA platform, a 20 meters depth underwater observatory cabled with a 4 km mixt cable to Vilanova i la Geltru's coast. Two months of continuous data have been collected in order to confirm their proper operation and long term North current characteristic from the area.

Keywords – ADCP, Doppler Effect, North current

I. INTRODUCTION TO THE DOPPLER EFFECT

The Doppler effect is the difference in frequency that can be appreciate in a wave when the observer is moving in different directions. In example, an observer walking into the waves will see more waves in a given interval than someone standing still, and this will see even more than an observer moving away [1]. ADCPs use the Doppler effect by transmitting sound at a fixed frequency and listening to echoes returning from scatterers in the water. These scatterers are everywhere in the ocean and they float in the water moving on average at the same horizontal velocity as the water. So ADCP receives sound echoed from the scatterers and Doppler-shifted to a different frequency proportional to their movement. The angular motion causes no Doppler shift, only the radial one.
ADCPs use multiple beams pointed in different directions in order to calculate different velocity components. With three beams, east, north and up velocity can be calculated and there's an extra one to estimate the validity of the sensor data.

II. OBSEA PLATFORM

OBSEA is an underwater observatory connected to the coast with a 4 km mixt cable that provides power and data. It is placed at a depth of 20 meters in a fishing protected area near the coast of Vilanova i la Geltrú. The main advantage of the cable observatory is the capacity to feed the station from the land up to 3.6 kW and the high bandwidth communication link of 1 Gbps. This gives the opportunity of observe in real-time multiple marine environment parameters.
The main objective of OBSEA is to have a test bed for the development of oceanographic instrumentation while providing real time data to the scientific community.
This platform counts on two subsea nodes in series and one Buoy connected to the first one. Further, there's a secondary buoy connected to the first recently

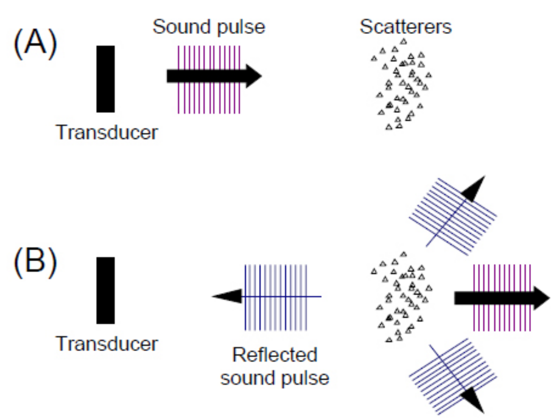

Fig 1. Backscattered sound. (A) Transmitted pulse; (B) A small amount of the sound energy is reflected back (and Doppler shifted), most of the energy goes forward.

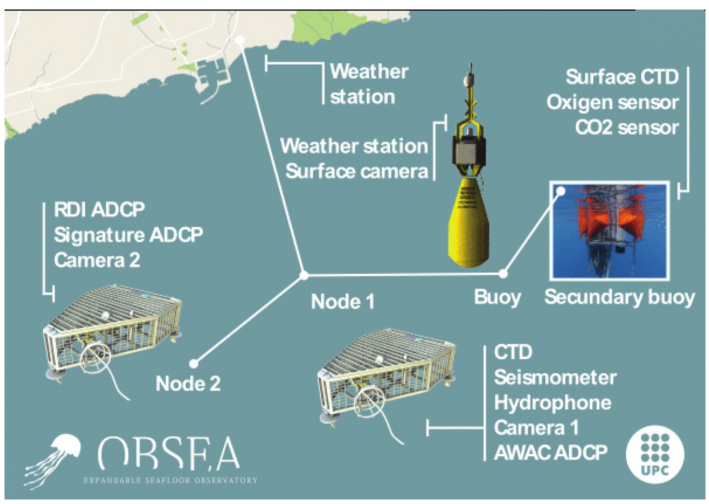

Fig 2. OBSEA platform distribution